Kansas Department of Transportation

# Strategic Highway Safety Plan

## Intersections

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# Intersections

## Introduction

The Federal Highway Administration (FHWA) defines an intersection as “a planned point of conflict in the roadway system.” In this plan, we define an intersection as two or more public roads crossing at grade (or at the same level). There are five types of intersections, two with traffic lights, three without.

- Signalized
  - Pre-Timed Traffic Signals
  - Traffic-actuated Signals
- Unsignalized
  - Uncontrolled (no stop or yield signs and no assignment of right-of-way)
  - Controlled (stop or yield signs assign right-of-way and may include flashing beacons)
  - Roundabouts

Given the FHWA definition of an intersection above, it is important to point out what is not counted as an intersection crash. The meeting of a private driveway with a public road won’t be treated as an intersection although we recognize the value of well-designed access, especially near intersections. Kansas averages about eight fatal crashes per year at driveways and parking lot accesses. Another type of crash that will not be treated as an intersection crash is those that occur at grade-separated interchanges (where roads cross at different levels) such as merge areas and ramps. Therefore, the only crashes reported here will be those that occur where two or more public roads cross at the same level, or be directly related to those crashes.

The purpose of the Intersections Emphasis Area Team, or EAT, is to develop data-driven action plans that reduce the potential for and severity of intersection crashes. The plan establishes performance measures and goals and proposes implementation strategies. These strategies are based on the 4E’s of traffic safety: engineering, education, enforcement and emergency medical services. The Intersections EAT will help implement the Strategic Highway Safety Plan, or SHSP, by recommending safety-related programs and projects. These programs and projects may include low-cost safety improvements deployed systemically, high-cost safety improvements deployed via safety programs or projects, policy changes, and research initiatives. The Intersections EAT first met October 14, 2009 and was represented by the following agencies:

- Mid-American Regional Council (MARC)
- City of Overland Park Planning and Development
- Shawnee County Public Works
- City of Manhattan Public Works
- City of Topeka Police Department
- Federal Highway Administration (FHWA)
- Kansas Department of Transportation (KDOT)

# Intersections

There is no shortage of strategies available to the highway safety practitioner. Our original SHSP, drafted in 2006, included a long list of potential strategies, but it did not prioritize them or plan for their implementation. In drafting the current plan, we have focused on implementation questions that will lead to more tangible outcomes. Examples of these questions are as follows:

- How can this plan shape existing safety programs, including funding levels and project selection?
- What tools can KDOT provide local jurisdictions with the jurisdiction wants to submit potential safety projects?
- How can this plan influence large-scale reconstruction projects?
- How can this plan shape legislative agendas?

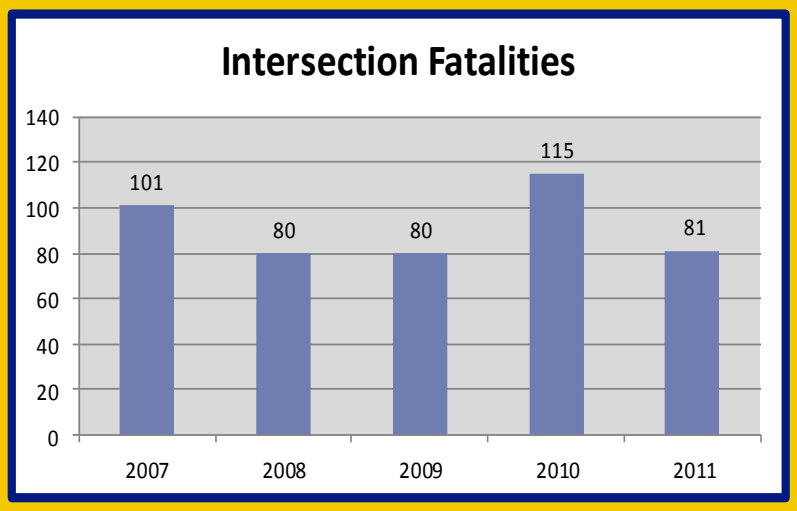
If we answer these questions correctly, the discovery of the findings will be an important step towards diminished numbers of fatal and serious-injury crashes. For instance, if we as a state reduce intersection -related fatalities by half from 2010 - 2029, over 500 lives will be saved during that period.

Analyzing intersection-crash data is essential to answering these questions. With input from the Data Support Team, the Intersections EAT will be able to select and prioritize strategies and make recommendations based on the problems the data will reveal.

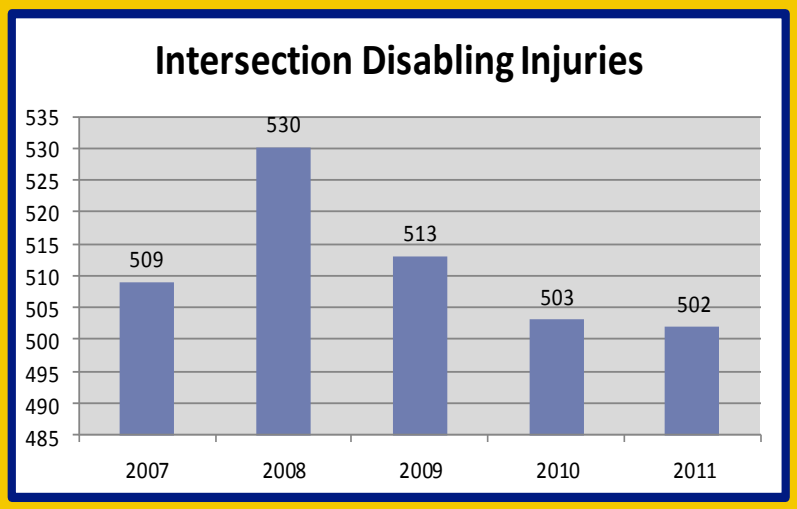
## Data Points

### 1. One in four Kansas crash fatalities happens at an intersection

Intersection-related fatalities represent roughly 23 percent of all crash fatalities in Kansas. Between 2007 and 2011 there were 457 fatalities and 2,557 disabling injuries at intersections. In that span, intersection crashes accounted for 30 percent of serious-injury crashes statewide and 30 percent of all crashes.




*Increases and decreases in intersection fatalities tend to parallel the pattern of fatalities overall.*

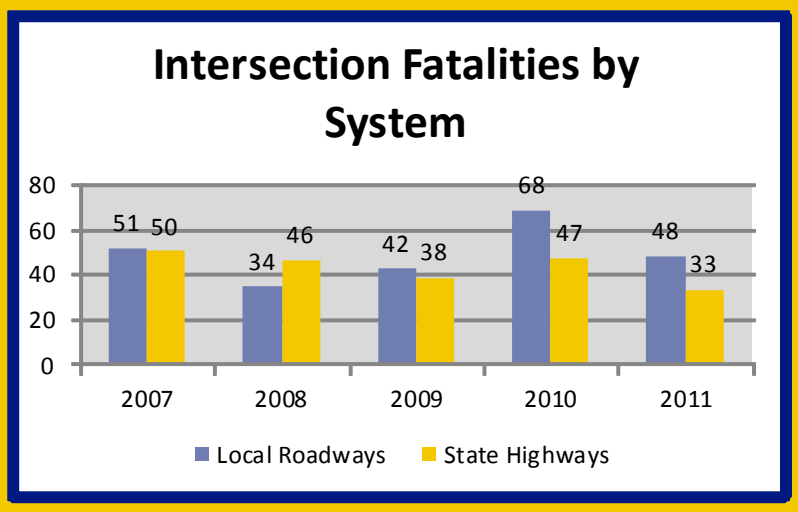


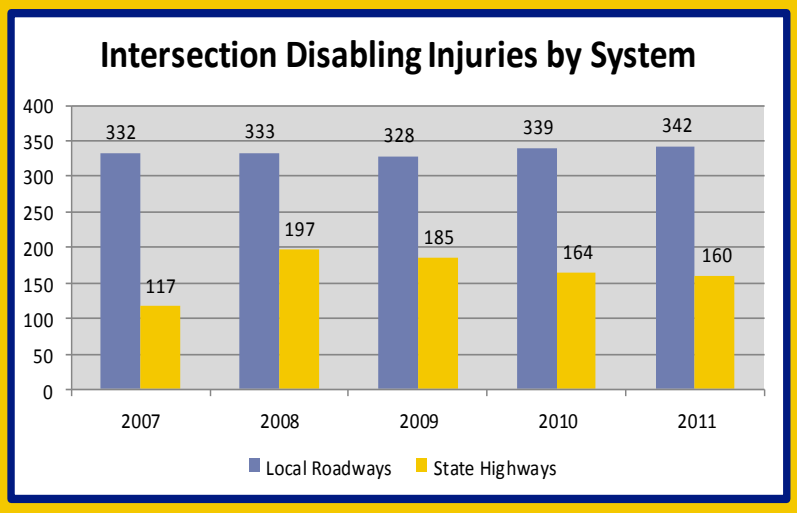

*With the exception of 2008, intersection disabling injuries were relatively steady.*

## 2. Controlled access reduces the potential for crashes

Between 2007 and 2009, 47 percent of intersection fatalities, compared to 52 percent of all fatalities, occurred on state highways. During the same time period, 35 percent of intersection-related disabling injuries, compared to 48 percent of all disabling injuries, occurred on state highways. It's likely that controlled-access policy along state highways save lives and prevent more serious injuries from happening. Interstates are made safer by having no intersections. On the contrary, locally-owned roads, particularly in urban areas, have more intersections with more conflict points and consequently a higher share of intersection crashes.

*Intersection fatalities have not shown a predictable pattern in recent years.*




*On local roads, disabling injuries resulting from intersection crashes have held steady in recent years. On state highways, there's been a decline in such injuries.*

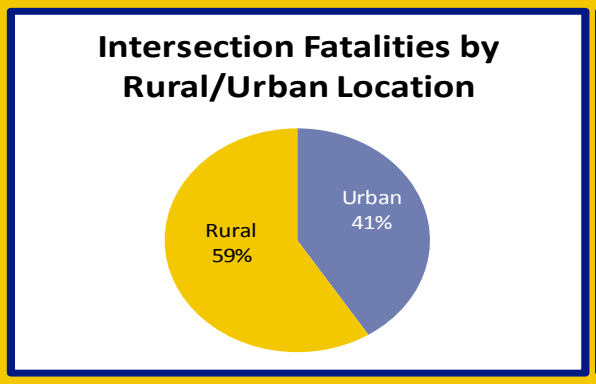
## 3. Crashes at rural intersections are more likely to be severe

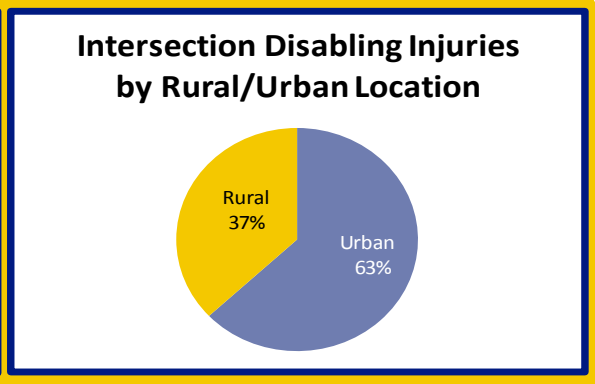
Of the 140,609 miles of public roads in the state, 91 percent are located in rural Kansas. By that measure, it's not surprising that there are more deaths caused by crashes on rural roads than on urban roads. Crashes at rural intersections account for 59 percent of all intersection fatalities.

By another measure, though, the high fatality percentage in rural Kansas is a surprise. Less than half of all vehicle miles traveled in Kansas -- 49 percent – are on rural roads. With vehicle miles traveled on rural and urban roads nearly equal, why do intersection crashes on rural roads result more often in fatalities or serious injuries?

Three factors play a role.

- **Higher speeds:** Less traffic, intersections and driveways mean that drivers are more comfort able traveling at high speeds.
- **EMS:** It takes longer for emergency vehicles in general and ambulances in particular to reach crash scenes and to deliver the injured to hospitals or trauma centers.
- **Health care facilities:** Patient needs may exceed the care capacity of rural health care facilities.

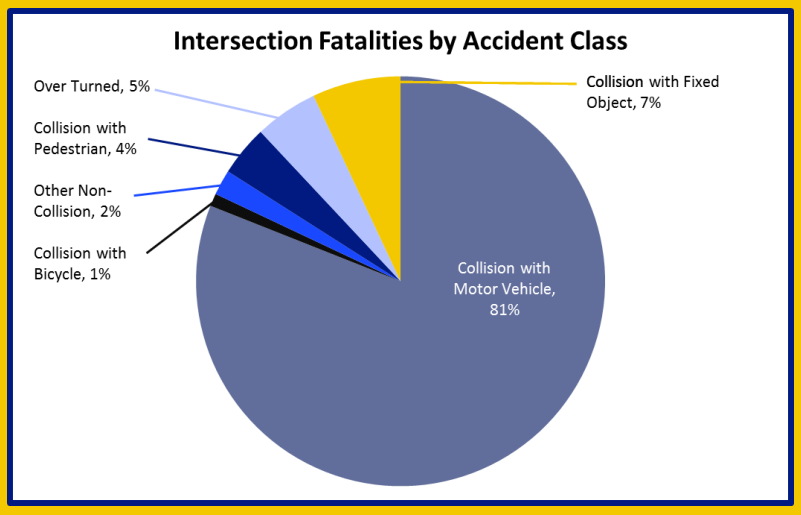


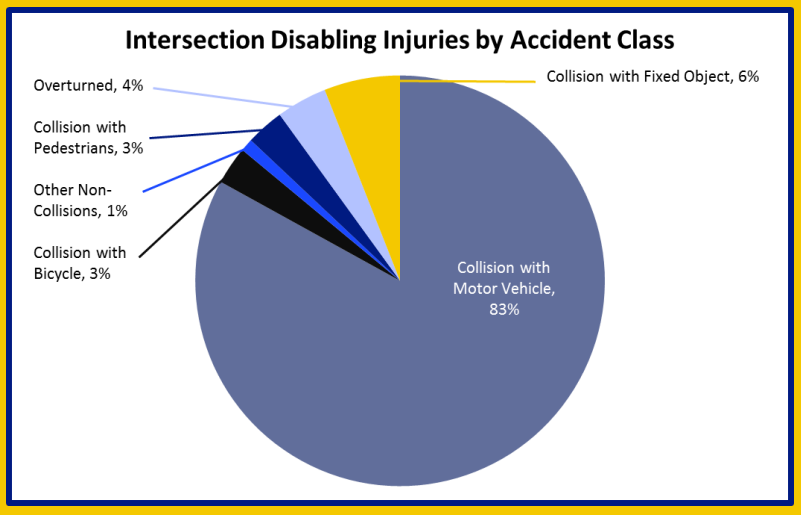




*Serious injuries in a rural area are more likely to result in death compared to those sustaining the same type of injury in an urban area. Rural areas of the state experience fewer intersection disabling injuries compared to the urban areas. However, 59 percent of intersection fatalities occur in the rural areas. The challenges of health care in rural areas may help explain this difference. There are often longer discovery times after a crash, greater EMS response times, longer travel distances to a hospital and fewer hospital resources (e.g., trauma surgeons, emergency physicians, sophisticated diagnostic radiology, and blood bank reserves).*

## 4. The most likely accident: collisions between vehicles

More than 80 percent of intersection crashes are collisions between vehicles. Rear-end and angle crashes are the most common types. The data indicate that our focus should be on reducing the potential for these conflicts. Reducing angle crashes begins with good engineering, but also depends on drivers' knowing who has the right of way – and enforcement of laws governing that. Reducing rear-end crashes requires managing traffic congestion by such means as timed signals and turn-lanes.



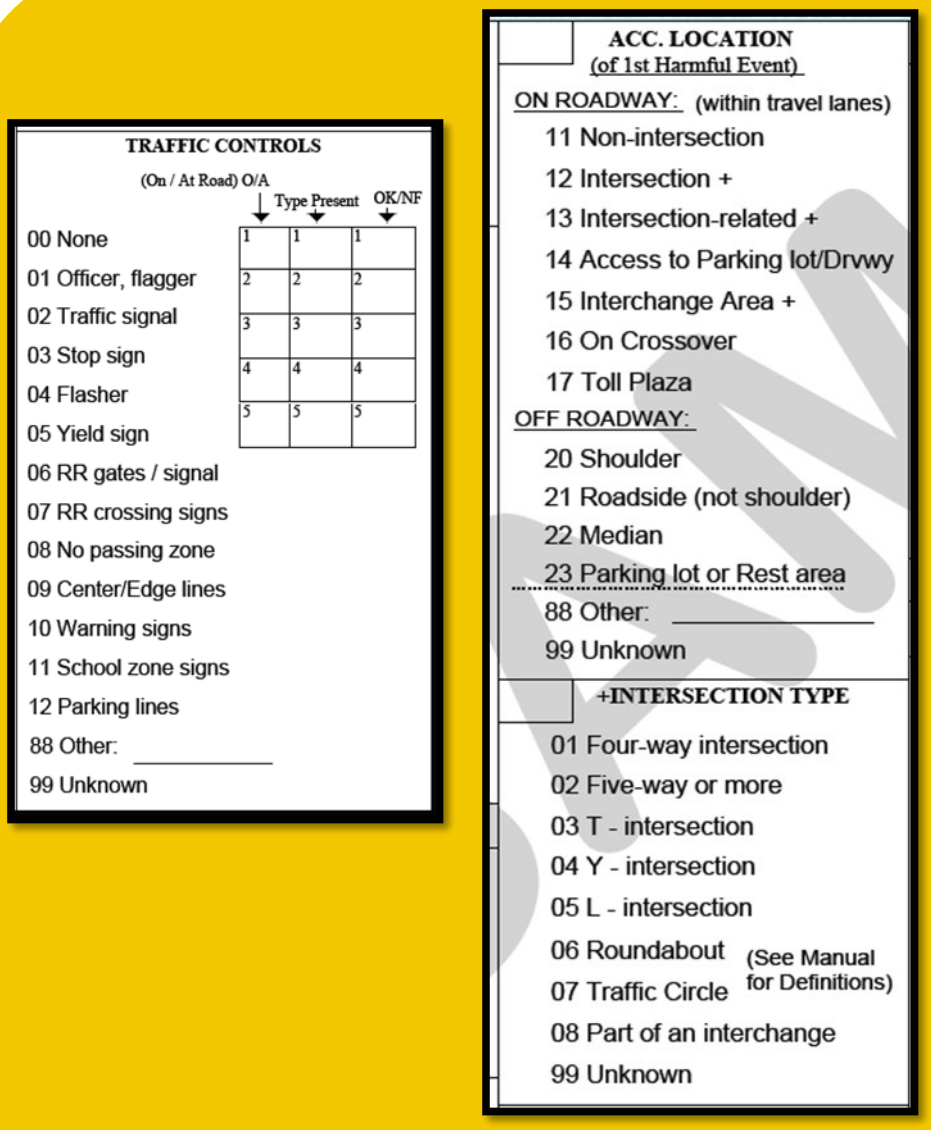
# Intersections

| Accident Class | Fatalities | Disabling Injuries |
|---|---|---|
| Collision with motor vehicle | 395 | 2117 |
| Overturned/rollover | 139 | 390 |
| Collision with fixed object | 29 | 164 |
| Collision with pedestrian | 14 | 96 |
| Collision with parked motor vehicle | 4 | 12 |
| Collision with bicycle | 3 | 77 |

*Between 2007 and 2011, collisions between motor vehicles accounted for 81 percent of the fatalities and 83 percent of the disabling injuries at intersections. Of these, 75 percent were angle collisions (left-turn and right-angle), 16 percent rear-end.*

## 5. A new crash reporting form enables detailed analysis

In 2009, a new crash reporting form allowed the collection of more detailed data about intersection types. Roundabouts, four ways, five ways, T's and Y's, for example, were assigned different numbers for coding purposes. Before 2009, the only information collected about intersections where crashes had occurred concerned traffic control measures such as signals, stop signs and yield signs. The causes and mitigation of intersection collisions will be analyzed in greater detail as additional data accrues.



**TRAFFIC CONTROLS**

| | (On / At Road) O/A | Type Present | OK/NF |
|---|---|---|---|
| 00 None | 1 | 1 | 1 |
| 01 Officer, flagger | 2 | 2 | 2 |
| 02 Traffic signal | 3 | 3 | 3 |
| 03 Stop sign | 4 | 4 | 4 |
| 04 Flasher | 5 | 5 | 5 |
| 05 Yield sign | | | |
| 06 RR gates / signal | | | |
| 07 RR crossing signs | | | |
| 08 No passing zone | | | |
| 09 Center/Edge lines | | | |
| 10 Warning signs | | | |
| 11 School zone signs | | | |
| 12 Parking lines | | | |
| 88 Other: _____ | | | |
| 99 Unknown | | | |

**ACC. LOCATION**
(of 1st Harmful Event)

ON ROADWAY: (within travel lanes)
- 11 Non-intersection
- 12 Intersection +
- 13 Intersection-related +
- 14 Access to Parking lot/Drvwy
- 15 Interchange Area +
- 16 On Crossover
- 17 Toll Plaza

OFF ROADWAY:
- 20 Shoulder
- 21 Roadside (not shoulder)
- 22 Median
- 23 Parking lot or Rest area
- 88 Other: _____
- 99 Unknown

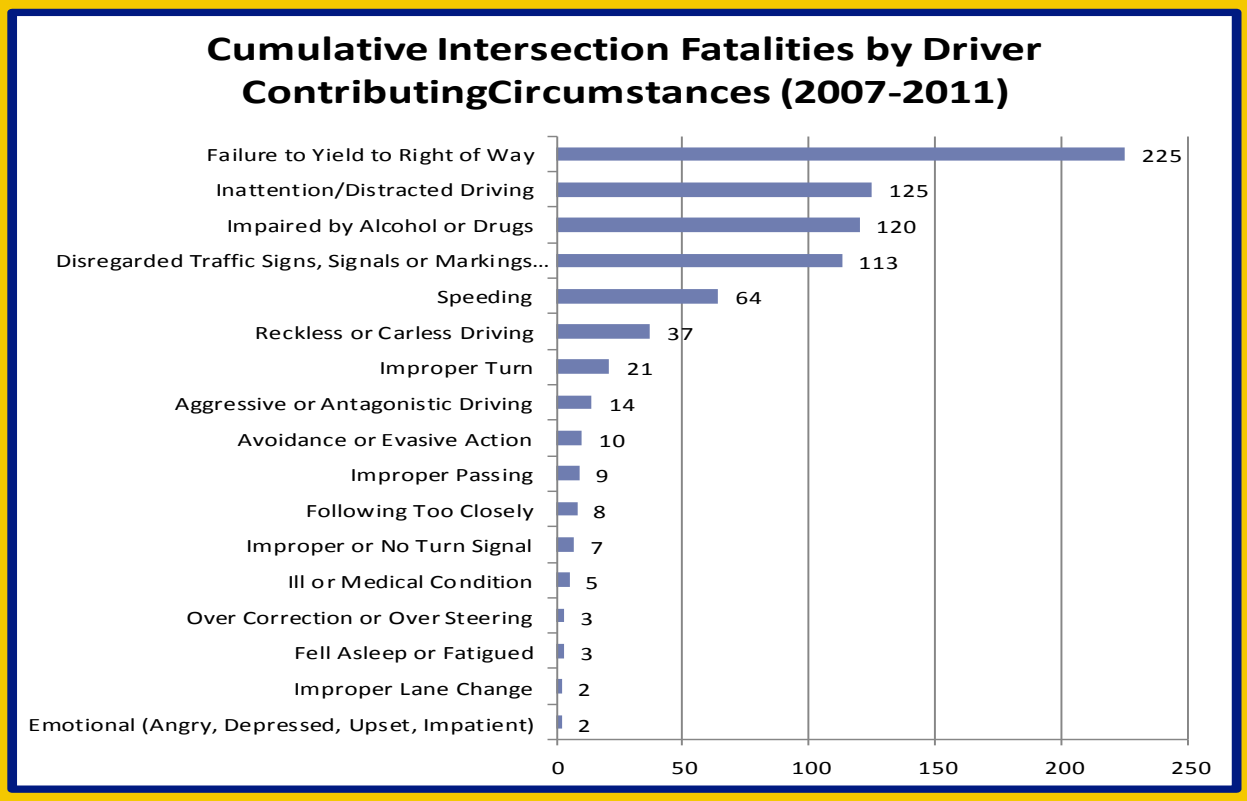
**+INTERSECTION TYPE**
- 01 Four-way intersection
- 02 Five-way or more
- 03 T - intersection
- 04 Y - intersection
- 05 L - intersection
- 06 Roundabout
- 07 Traffic Circle
- 08 Part of an interchange
- 99 Unknown

(See Manual for Definitions)

*The crash reporting form introduced in 2009 lists more options under "Traffic Controls" and "Accident Location" and adds a new category: "Intersection Type."*

## 6. The contribution of driver behavior to intersection collisions

Most intersection fatalities are the result of a collision between two vehicles and most of those collisions occur between vehicles moving at 90 degree angles to each other. Given this information, it's not surprising that "failure to yield right-of-way" and "disregarded traffic signs, signals or markings" represent two of the top four factors involved in collisions. Cell phone usage inside and outside of vehicles has skyrocketed within the last decade. Given this trend, it is not surprising that inattention/distracted driving" is noted as the second largest contributor to intersection crashes, The remaining factor in the top four, driving while impaired by alcohol or drugs, is all too familiar. Additional information regarding this category of fatalities/serious injuries can be found in the impaired driver chapter of this plan.

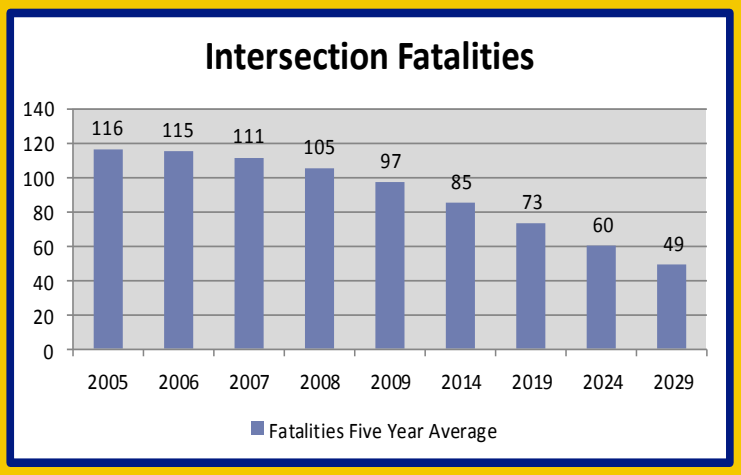


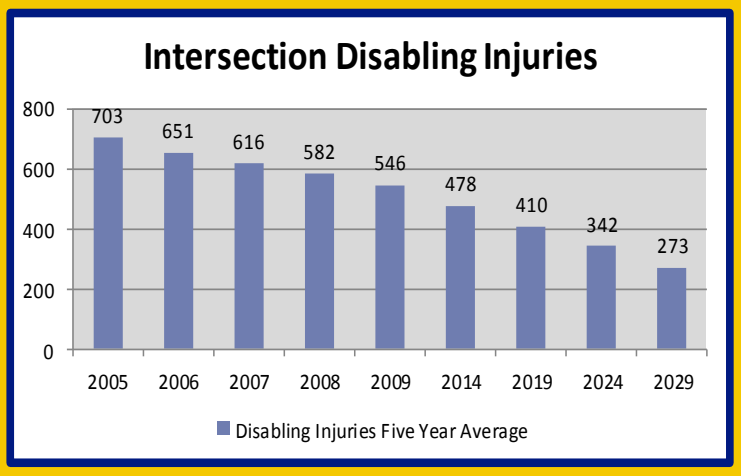

*Increased police presence could reduce many of the driver behaviors that lead to Intersection fatalities.*

## Performance Measures

Consistent with the overall SHSP goal, the Intersections EAT aims to halve intersection fatalities and serious injuries within 20 years. Focusing on serious injuries as well as fatalities makes sense, since serious injury crashes are often an indicator of potential fatal crashes. For the five-year period 2005 through 2009, Kansas averaged 97 intersection and intersection-related fatalities and 546 disabling injuries per year. In order to meet our goal, we must, on average, reduce fatalities during the 2025 to 2029 period by an average of at least 49 per year, and disabling injuries by at least 273 per year.

The SHSP is a key tool in accelerating the trend toward decreased intersection collisions seen in recent years. Interim goals will help us measure our progress. The Intersections EAT chose to use a straight-line projection to set interim goals – that is, to consistently reduce intersection fatalities by two or three a year. A straight line projection was made because the EAT felt most of the "simple" fixes have already been applied statewide. These include strategies such as all-red time intervals between green signals, 12" signal lenses, back-plates on signal housing, mast-arms that put signals over the lanes, and dilemma-zone protection for signalized intersections and pavement markings such as turn-arrows and stop lines. The next figure shows our interim five-year goals, in terms of fatalities, represented here by blue bars



## Goals and Strategies

To reduce serious injury and fatal crashes at intersections on all public roads statewide, the Intersections EAT developed the following list of intermediate goals.

1. Create and manage data-driven safety programs that make the best use of safety dollars.
2. Make use of available traffic records, crash date and roadway data to identify projects de signed to make intersections safer.
3. Experiment with innovative engineering countermeasures.
4. Promote proven engineering countermeasures.
5. Use law enforcement to encourage good behavior.
6. Promote education campaigns that focus on the factors most often linked to intersection crashes.

Some techniques for reducing intersection collisions cost little or nothing. Examples of little or no cost countermeasures include timing traffic light changes so that for a brief interval all signals show red, allowing an intersection to clear before right-of-way is reassigned. Other measures, such as the construction of roundabouts to reduce conflict points and lower vehicle speeds, are more expensive. The challenge for the Intersections EAT is to identify, prioritize and implement realistic strategies.

**Goal 1: Create and manage data-driven safety programs that make the best use of safety dollars.**

Current Strategies:

- Maintain sign retro-reflectivity (visibility when lighted by headlights) on state highways by replacing sign sheeting at scheduled intervals.
- Promote good access management near intersections through a corridor management policy.
- Perform improvements of crash-prone intersections under the support of a federal Highway Safety Improvement Program (HSIP) initiative designed to make intersections safer.
    - Background: Kansas has benefited from its involvement with the HSIP program, and its predecessors, since the 1970s. Intersection crashes have declined and the part partnership has created strong working relationships between KDOT traffic engineers and city public works staffs. Typical projects include converting stop signs to traffic signals**,** replacing pedestal-mounted signals with overhead signals, installing traffic-actuated signals, constructing roundabouts and constructing turn lanes.

New Strategy:

- Recommend new distribution of Highway Safety Improvement Program, or HSIP, funding based on Kansas crash statistics. *See Roadway Departure chapter for action plan.*

# Intersections

**Goal 2: Make use of available traffic records, crash data and roadway data to identify projects designed to make intersections safer.**

Current Strategies:

- Promote the Traffic Engineering Assistance Program (TEAP) to assist with traffic studies on locally owned roads,
- Complete geo-coding—the assignment of latitude and longitude–- of crashes on local roads.

New Strategies:

- Develop a method to project the expected number of crashes based on intersection types and traffic volumes in order to identify intersections with the potential for improvement.
  - Background: KDOT wants to utilize safety performance functions (SPF) and crash modification factors (CMF) as the basis for determining low-cost, system wide improvements and high-cost projects at specific sites. Both SPF and CMF are key elements of the Highway Safety Manual published in 2010 by the American Association of State Highway and Transportation Officials. KDOT is currently using a software tool called Safety Analyst to analyze crash, volume and roadway data. Safety Analyst was developed by the FHWA in cooperation with a number of states, including Kansas. Using this software will support a more sophisticated analysis of the Kansas highway system. KDOT will also develop an application that helps local jurisdictions predict crash frequencies at different types of
  - Method: research
  - Costs: $50,000 per year (estimated)
  - Lead agency and contract: KDOT, Traffic Safety Section
  - Challenges: reliability of the data
  - Target date: begin integration into planning process in 2014
- Create an intersection inventory to aid crash analysis. *See Data Support for action plan.*

Future Strategies

- Identify and analyze recurring variables related to intersection crashes.
- Facilitate access by local jurisdictions to KDOT crash data.
- Improve the quality and consistency of crash reporting by law enforcement.
- Establish a grading system for intersections to rank them based on safety.

**Goal 3: Experiment with innovative engineering countermeasures.**

Current Strategies:

- Experiment with innovative intelligent transportation systems (ITS) applications
  - Background: KDOT has experimented with warning signs that are activated for traffic that has the right of way when a vehicle is detected on a side street
- Review policy on left-turn lanes vs. bypass lanes at rural high-speed intersections.

New Strategies:

- Promote research into experimental low-cost countermeasures.
  - Background: Specific countermeasures are often described as experimental, tried or proven. The effort here will be to promote research on experimental strategies that leads to proof of their viability. This will be accomplished by working through state programs like KTRAN and federal programs like the National Highway Cooperative Research Program. This strategy will also require working with organizations like the Local Transportation Assistance Program (LTAP) at the University of Kansas (KU) and the American Public Works Association to stimulate local participation.
  - Method: research
  - Costs: $100,000 per year (estimated)
  - Lead agency and contact: KDOT, Traffic Safety Section
  - Challenges: finding locations for build-to-evaluate countermeasures
  - Target date: 2014

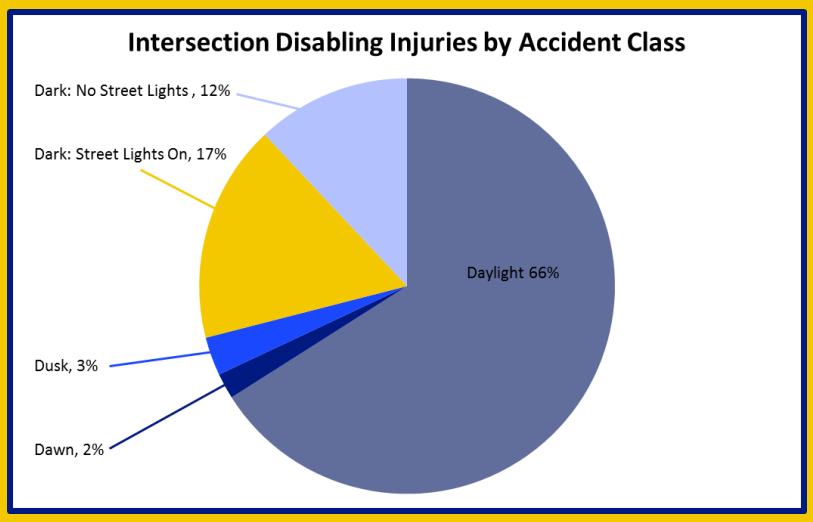
Future Strategies:

- Consider experimenting with rural intersection collision avoidance systems
  - Background: This system is currently being tried in some other Midwestern states. Based on vehicle detection on major thoroughfares, it determines safe distances between vehicles in traffic and informs side street drivers when to proceed

**Goal 4: Promote proven engineering countermeasures.**

Current Strategies:

- Promote and construct roundabouts.
- Promote and conduct road safety audits and assessments.
- Provide street lighting at higher-volume intersections and interchanges.




*Nearly a third of all intersection fatalities occur between dusk and dawn, despite decreased traffic volume during those hours.*

- Provide left-turn and right-turn lanes at intersections.
- Realign intersection approaches to reduce or eliminate intersection skew.
- Install dilemma-zone protection at signalized intersections.
- Optimize clearance intervals, including the all-red and yellow.
- Coordinate traffic signals along urban corridors.
- Install flashing solar-powered beacons on intersection warning and stop signs where appropriate.
- Install transverse rumble strips across the stop approach lanes in rural areas where appropriate.

Future Strategies:

- Promote advance street name signs at intersections.
- Simplify the configuration of low traffic-volume, two-way, stop-controlled intersections.
- Encourage signal pre-emption that gives right-of-way to emergency vehicles.

**Goal 5: Use law enforcement to encourage good driver behavior.**

New Strategy:

- Develop a program to fund targeted enforcement programs at high-crash intersections.
  - Background: Speeding contributed to at least 64 fatalities between 2007 and 2011. Disregard of signs, signals or markings contributed to at least 113 fatalities during this time period. It's widely recognized that the presence of law enforcement improves driver behavior. The motorist is more likely to drive at a reasonable speed, drive defensively, and obey signs, signals and markings when a law enforcement officer is within sight. Less well-known is that enforcement of traffic laws appears to reduce crime rates overall. The retention of strong traffic enforcement units within law enforcement agencies, therefore, may be a benefit at many levels. We recommend the creation of a program (and the promotion of existing programs) that fund overtime law enforcement at specific intersections and the development of lines of communication between law enforcement and public works employees about "hot spots."
  - Method: program
  - Costs: TBD
  - Lead agency and contact: KDOT, Traffic Safety Section
  - Challenges: identify high-crash intersections and prioritizing those that receive increased attention if demand exceeds funding.
  - Target date: FY 2014

Future Strategies:

- Use the media to promote awareness of the link between vigorous traffic-law enforcement and reduced crime.
- Encourage law-enforcement agencies to concentrate more resources on traffic law enforcement.

**Goal 6: Promote education campaigns**

Current Strategies:

- Provide public works and law enforcement officials with training and educational materials through LTAP at KU and the Traffic Assistance Services for Kansas program at K-State.
- Promote media campaigns highlighting the danger of impaired or distracted driving.

Future Strategies:

- Develop guidelines and procedures for consultants, state engineers and local engineers to complete traffic studies and intersection crash analyses.